Ozone Retrieval From SAGE III Limb Scattering (Background)

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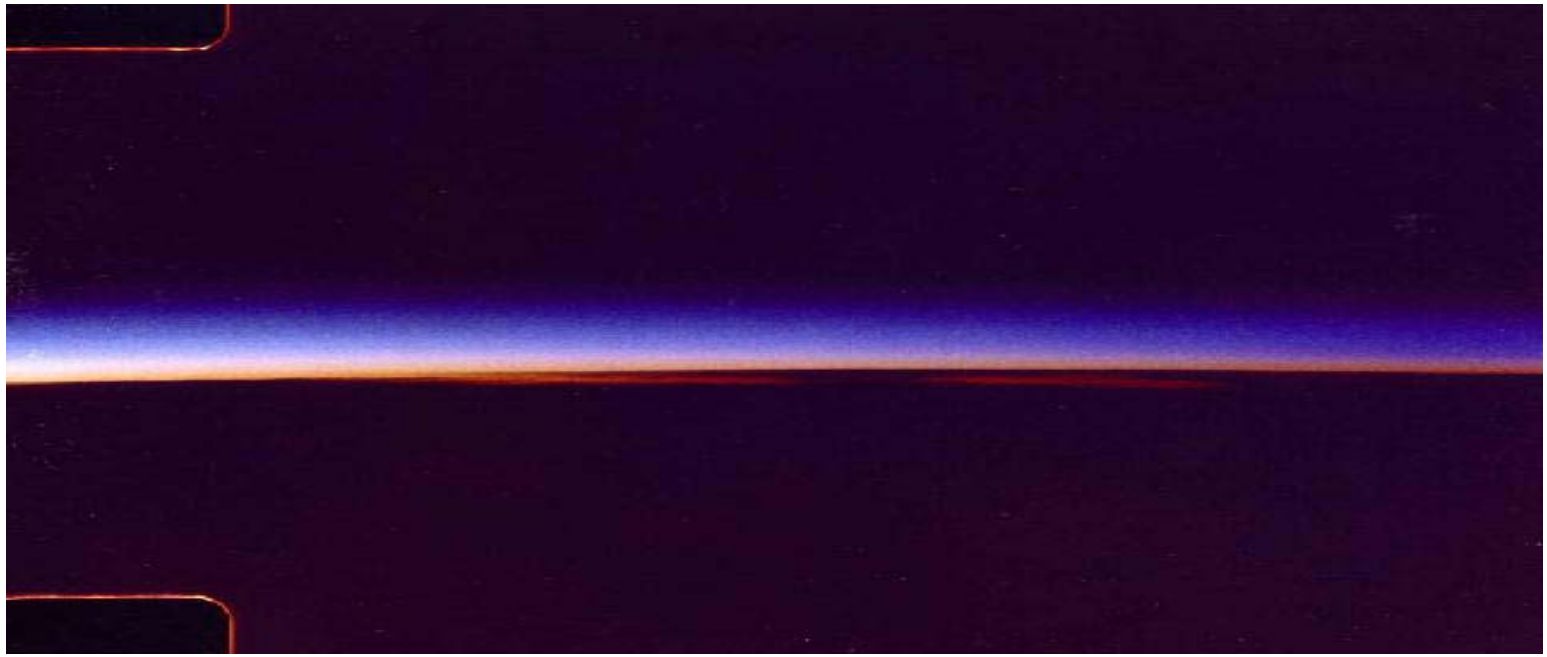
Outline

- **Limb Scattering (LS) Measurement Methodology**
  - Definition and main characteristics
  - LS history and present instruments
- **Application of LS to Ozone Profile Retrieval**
  - Sensitivity of LS signal to Ozone
  - Retrieval algorithm description
  - Primary error sources
- **Error Mitigation Strategies**
- **Primary Goals of Investigation**

Limb Scattering Measurement Methodology



- Measure scattered solar radiance (not transmitted)
  - Measurement possible over whole sunlit side
  - Flexible pointing, increased geographic coverage
- Can we infer profiles with similar accuracy / precision?

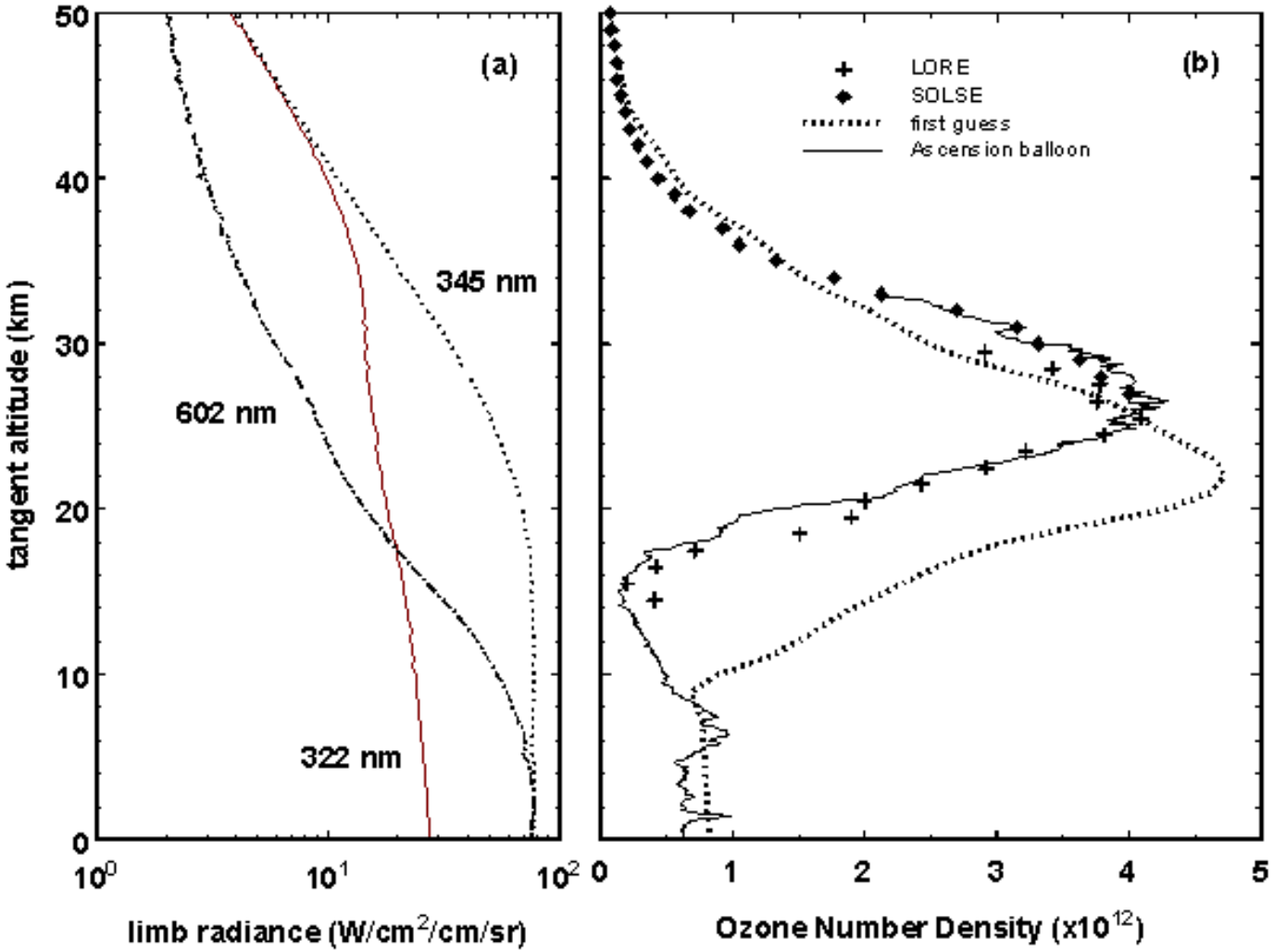
Limb Scattering Challenges

- Proximity of relatively bright Earth (stray light)
- Upwelling scattered light from inhomogeneous scene
- Pointing / altitude registration (no target)

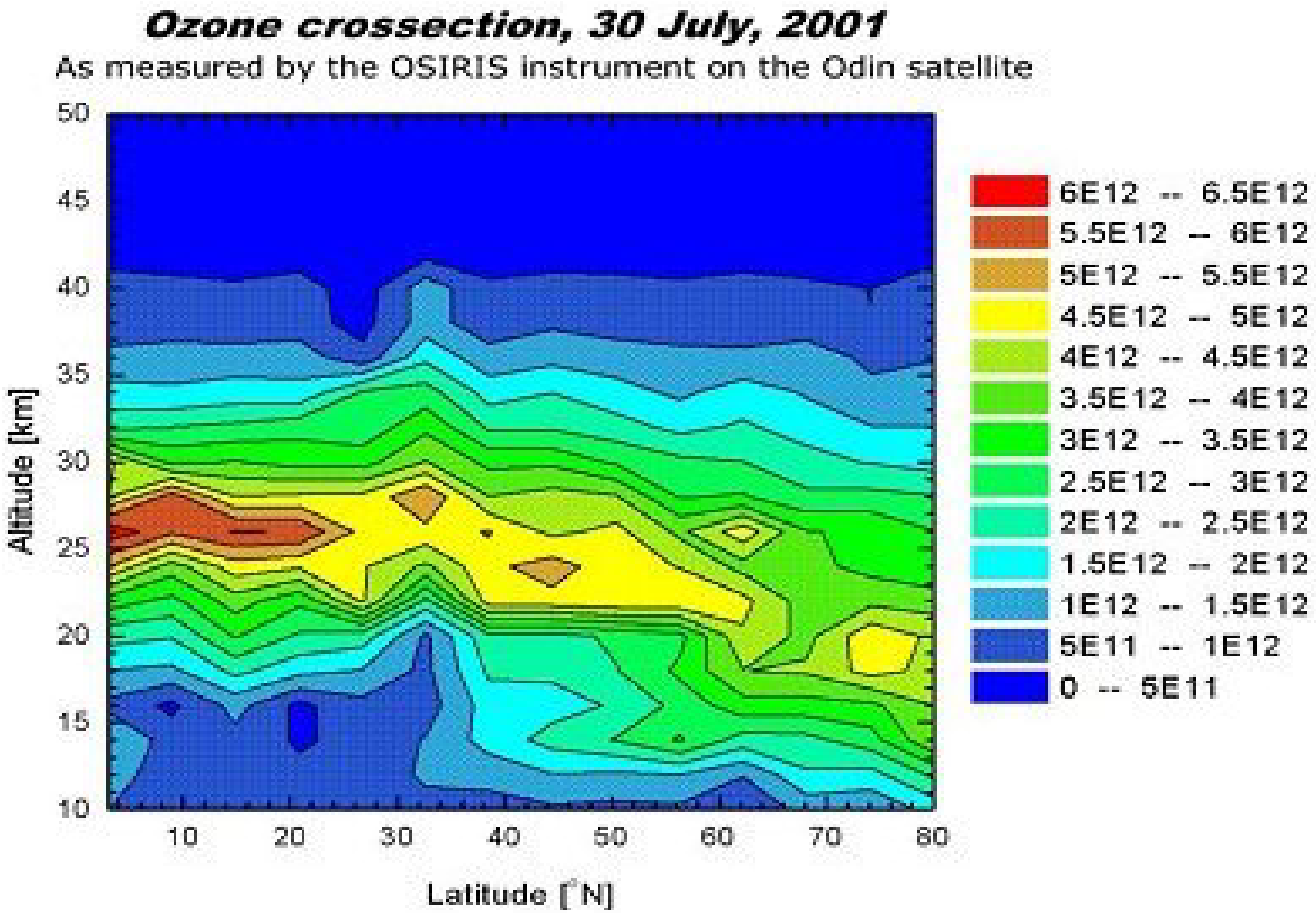
Limb Scattering History

- Proposed at least 30 years ago to infer profiles
- Early rocket experiments detect aerosol layers
- SME (1981-1989) – O_3, H_2O, NO_2, aerosol, T
- SOLSE/LORE (1997) – Stratospheric O_3

LS results from first SOLSE/LORE flight



Sample LS Ozone Retrieval (OSIRIS data)



Instruments making LS Measurements

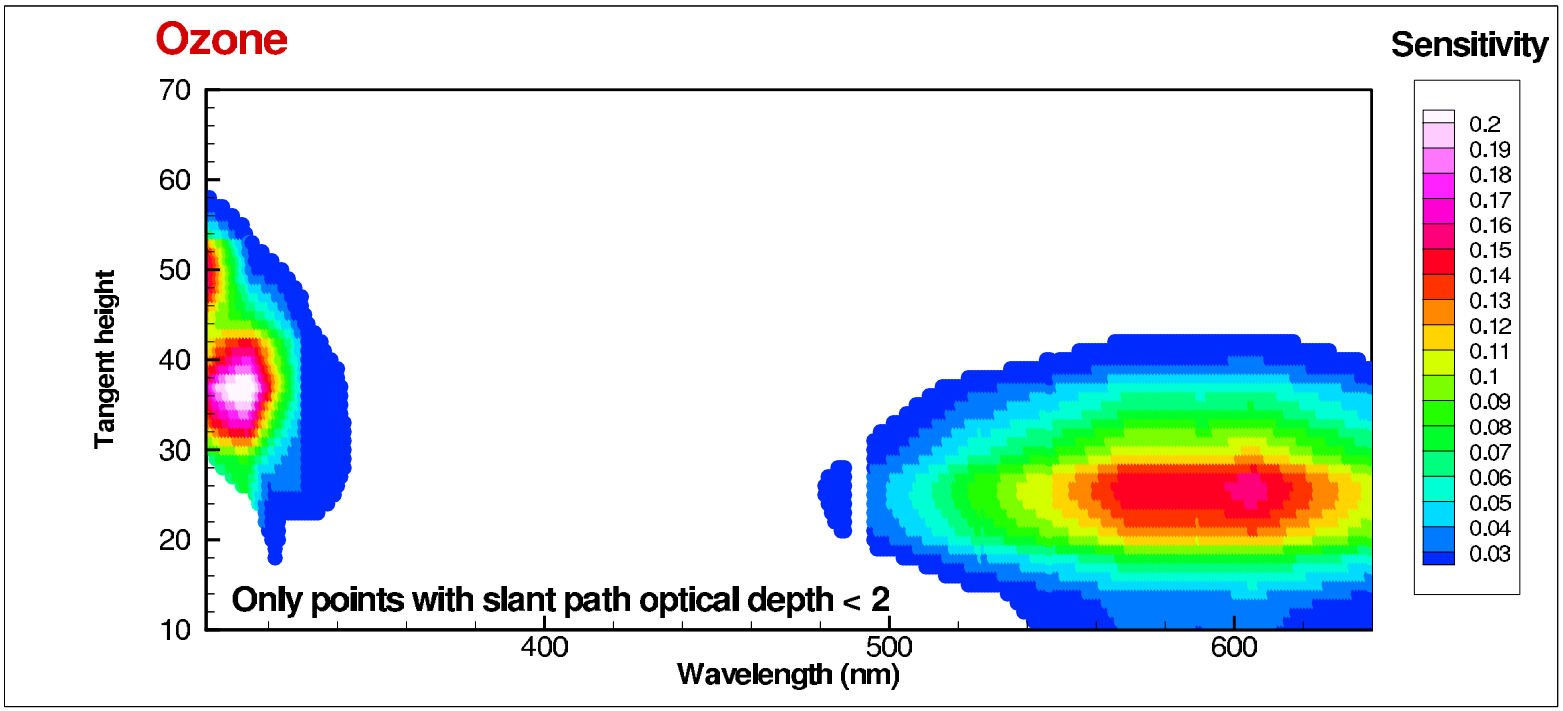
Present / Recent Measurements

- OSIRIS on ODIN(2001): Visible and UV
- SCIAMACHY on ENVISAT (2002): 240 – 2380 nm
- *SAGE III on METEOR (2002): 290 - 1000 nm*
- SOLSE/LORE on Columbia (2003): Visible and UV

Future Measurements

- OMPS on NPP (2006) and NPOESS (2011) will rely on LS for ozone profiling

LS Sensitivity to Ozone

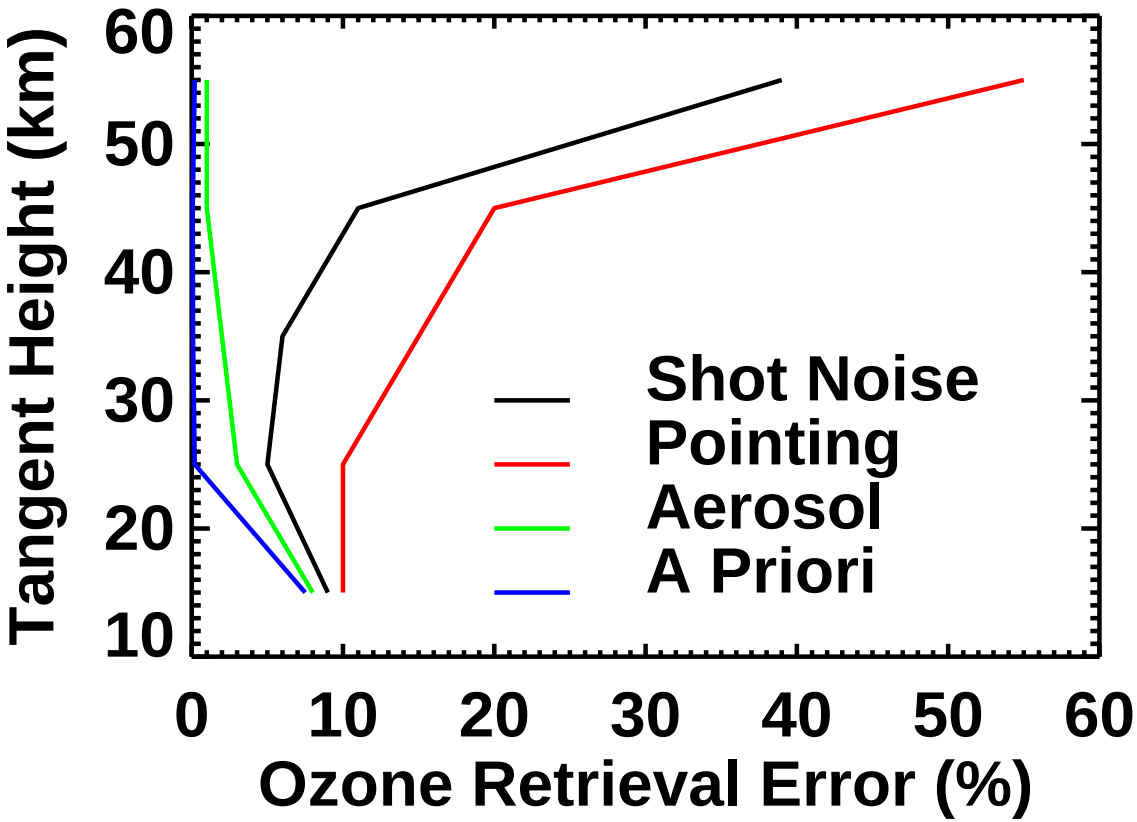


- UV wavelengths needed for altitude > 40 km
- Visible wavelengths needed for altitude < 30 km
- Sharply peaked kernels -> Potentially high vertical resolution

Brief description of ozone retrieval algorithms

- Use tangent height normalization to reduce sensitivity to surface reflection, absolute radiometric calibration and polarization
- Use wavelength grouping to reduce sensitivity to aerosols
- Infer ozone profiles using differential method (***Flittner et al.,*** 2000) and MLR / DOAS technique

Primary Sources of LS Ozone Retrieval Error



- Pointing dominates at every altitude
- This analysis did not include stray light!

Error Mitigation

- **Stray light**: SAGE III has no baffle in front of mirror
  - Need to characterize the effective spatial slit function
- **Pointing:** Major source of uncertainty for all LS instruments
  - Presently use RSAS algorithm
  - Investigating alternatives to achieve better than 1 km accuracy
- **Aerosols:** Presently rely on algorithm to minimize effect on ozone retrieval
  - Plan to retrieve aerosol properties as we refine our approach
- **Scene Non homogeneity** (Clouds, surface albedo)

Primary Goals of Present Investigation

- Retrieve ozone profiles from SAGE III LS data
- Qualify retrievals by comparing with correlative data from SAGE III occultations, ozonesondes, SOLSE/LORE, OSIRIS, SCIAMACHY, LIDARs, …
- Identify, quantify, and minimize main sources of errors (stray light, pointing, aerosol, inhomogeneity)
- Eventually, construct an ozone profile retrieval algorithm for routine operation